

Notes on the Northern Records of *Aedes (Stegomyia) riversi*
Bohart and Ingram

Motoyoshi Mogi
Department of Medical Zoology, Nagasaki University
School of Medicine, Nagasaki 852, Japan

ABSTRACT. *Aedes (Stegomyia) riversi* Bohart and Ingram is recorded for the second time from Tsushima, an island north of Kyushu, Japan. This record confirms that *riversi* is indigenous to Tsushima. Distribution records from two islands west of Kyushu are also included. The origin of these northern populations is discussed.

Introduction

Aedes (Stegomyia) riversi is shown in the English literature as being endemic to the Ryukyu Islands (e.g., Huang, 1972). However, the Japanese literature carries records of this species from outside the Ryukyus. Omori and Ito (1961) recorded it from Tsushima, an island north of Kyushu. Kamimura (1968) recorded it from Yakushima, an island just south of Kyushu. In a recent paper by Tanaka *et al.* (1975), Cape Sata, the southern extremity of Kyushu, was also included in its distribution, probably for the first time from Kyushu proper. Therefore, Tsushima is apparently the northernmost locality presently known for this species.

Recently, while making a mosquito survey on Tsushima, I collected *A. riversi* again and confirmed the indigenosity there of this mosquito, which had usually been considered to be subtropical. In this connection, it is noteworthy that *riversi* was previously collected on two islands west of Kyushu by Drs. Omori and Suenaga. These valuable specimens are now preserved in our Department. My report, written in Japanese (Mogi, in press) mentions these records but does not include precise collection data. Data concerning *riversi* collected in the islands north or west of Kyushu are presented here along with some discussion on the origin of the northern populations of this mosquito.

Records

Tsushima Island.

The first record: 1 larva, Nishidomari, Kami-tsushima, 30 VIII 1957, washbasin in a shrine, N. Omori and O. Suenaga. 15 larvae and 1 female reared from larva, Minato, Kami-agata, 31 VIII 1957, tree hole, N. Omori and O. Suenaga.

The second record: 3 females, 7 VIII 1975; 1 female, 8 VIII 1975; 2 females, 22 VIII 1975 Sao-zaki, Kami-agata, biting collection, M. Mogi.

Fukue-jima Island.

2 females and 1 male, 25 V 1954, Arakawa, Tamanoura, biting collection, O. Suenaga.

Danjo Islands.

3 females and 3 males, 28 V 1954; 3 females, 29 V 1954; Oshima, biting collection, O. Suenaga. 2 males reared from larvae, 28 V 1954, Oshima, tree hole, O. Suenaga.

Discussion

The known distribution of *Aedes riversi* is shown in Fig. 1. This is one of the common species throughout the Ryukyu Islands (Amami, Okinawa and Yaeyama Islands) except for the Miyako Islands. The records north of Yakushima are, however, very local and generally widely separated from one another. Among the five records north of Yakushima, four are from widely separated islands. The record from Cape Sata is the only one from the main islands of Japan, as stated previously.

Isolated distributions can be explained in one of two ways. They may be caused by pioneer populations of a species expanding its range or, to the contrary, they may represent relict populations of a species that is reducing its distribution. In other words, the former is an early phase of species expansion, while the latter is a late phase of species reduction. It is of interest to discuss the situation of *Aedes riversi* north of Yakushima.

Undoubtedly, one of the most important factors influencing the survival of mosquitoes of subtropical origin in the temperate region is winter temperature. Accordingly, the distribution of mean temperature of the coldest season (January) of south Japan is shown in Fig. 2.

In the Ryukyus, *Aedes riversi* can be observed throughout the year, but nothing is known about the diapause potential, developmental temperature zero point and cold resistance of Ryukyu's *riversi* under severer conditions than those of the Ryukyus. However, the developmental temperature zero points for subtropical mosquitoes are often not much higher than 10°C. Accordingly, settlement may be possible in regions where the lowest annual mean temperature exceeds 10°C, irrespective of diapause potential.

In this respect it is noteworthy that Cape Sata is situated to the south of the January isothermal line of 10°C. This means that the climatic conditions of Cape Sata and the islands south of Kyushu, although very severe, may permit the settlement of Ryukyu's *Aedes riversi* irrespective of its diapause potential. Furthermore, Yakushima and Cape Sata are located in a region easily invaded from the south, by insects. In fact, it is well known that *Precis almana* Linn., a tropical and subtropical butterfly, became established on Cape Sata about 15 years ago, for the first time on the Japanese main islands. There seems to be no published record of the occurrence of *riversi* on Tokara Islands between Yakushima and Amami, but this may be due to the lack of mosquito surveys there. In short I can not find, at least from a distributional viewpoint, any thing strongly unreasonable in regarding *Aedes riversi* on Cape Sata and Yakushima as pioneer populations having been derived from the main population in the Ryukyus.

Next I must consider the situation of Tsushima, which is the northernmost locality for *Aedes riversi*. The known records of *riversi* on Tsushima are limited to the northernmost part of this island. One of the two records of 1957 was from the northeast extremity and the other from the northwest extremity. The records in 1975 were also from the northwest extremity, situated near to the place where one of the 1957 records was obtained. Therefore *Aedes riversi* is thought to be indigenous to Tsushima, at least on the northwest part.

Three ways can be postulated as methods of invasion or introduction for *Aedes riversi*, i.e., the movement of adults on air currents, the drift of trees and containers with eggs by sea currents and movement associated with the activities of man. In the last one, all stages may be involved. Considering its geographical position, however, Tsushima is probably not easily invaded by *riversi* from the south by such means. In every respect it seems reasonable to suppose that the southern and western seashores of Kyushu are as easy as or easier targets than Tsushima for such an invasion.

As for ease of settlement, the climatic conditions of Tsushima are also no more suitable than those of the Kyushu mainland. The January mean temperature of northwest Tsushima (which is the coldest region in Tsushima) lies between 4°C and 6°C (Fig. 2), while almost all of the Kyushu mainland, except for mountainous regions, is included in the range where the January mean temperature exceeds 4°C. The climatic conditions for the southern and western seashores of Kyushu are even more suitable than those on Tsushima, because the January mean temperature of those regions is higher than 6°C. The same situation is true when considering the other temperate conditions such as January mean daily minimum temperature, January mean daily maximum temperature and the annual number of days with minimum temperatures of less than 0°C. As far as the climatic conditions are concerned, not only Kyushu but also the southern seashore regions of Shikoku and west Honshu are included in the range where Tsushima's *Aedes riversi* can settle.

Considering these points, I am now inclined to regard the hypothesis that *Aedes riversi* on Tsushima is a relict population as a more acceptable one than the hypothesis that it is a pioneer one. Populations on Cape Sata and Yakushima can be regarded as pioneer ones as stated previously, but they can also be regarded as relict populations without any objection. The situation of the Danjo Islands and Fukue-jima Island lies between that of Yakushima and Tsushima. The possibility of there being pioneer populations becomes less in the more northern localities.

More knowledge on the distribution is necessary to make clear the origin of northern populations of *Aedes riversi*. At present we do not have unquestionable knowledge as to whether *riversi* occurs in the south part of Tsushima, Kyushu proper (other than Cape Sata), Shikoku and Honshu. The settlement on Fukue-jima and the Danjo Islands is also uncertain, because there have been no further collections.

Useful suggestions on the origin of the northern populations of *Aedes riversi* might be gotten from comparative studies on the morphology and physiology of each population. Like many other *Stegomyia* species, *Aedes riversi* can be colonized easily and the Tsushima strain of *riversi* is being maintained in our laboratory now for such studies.

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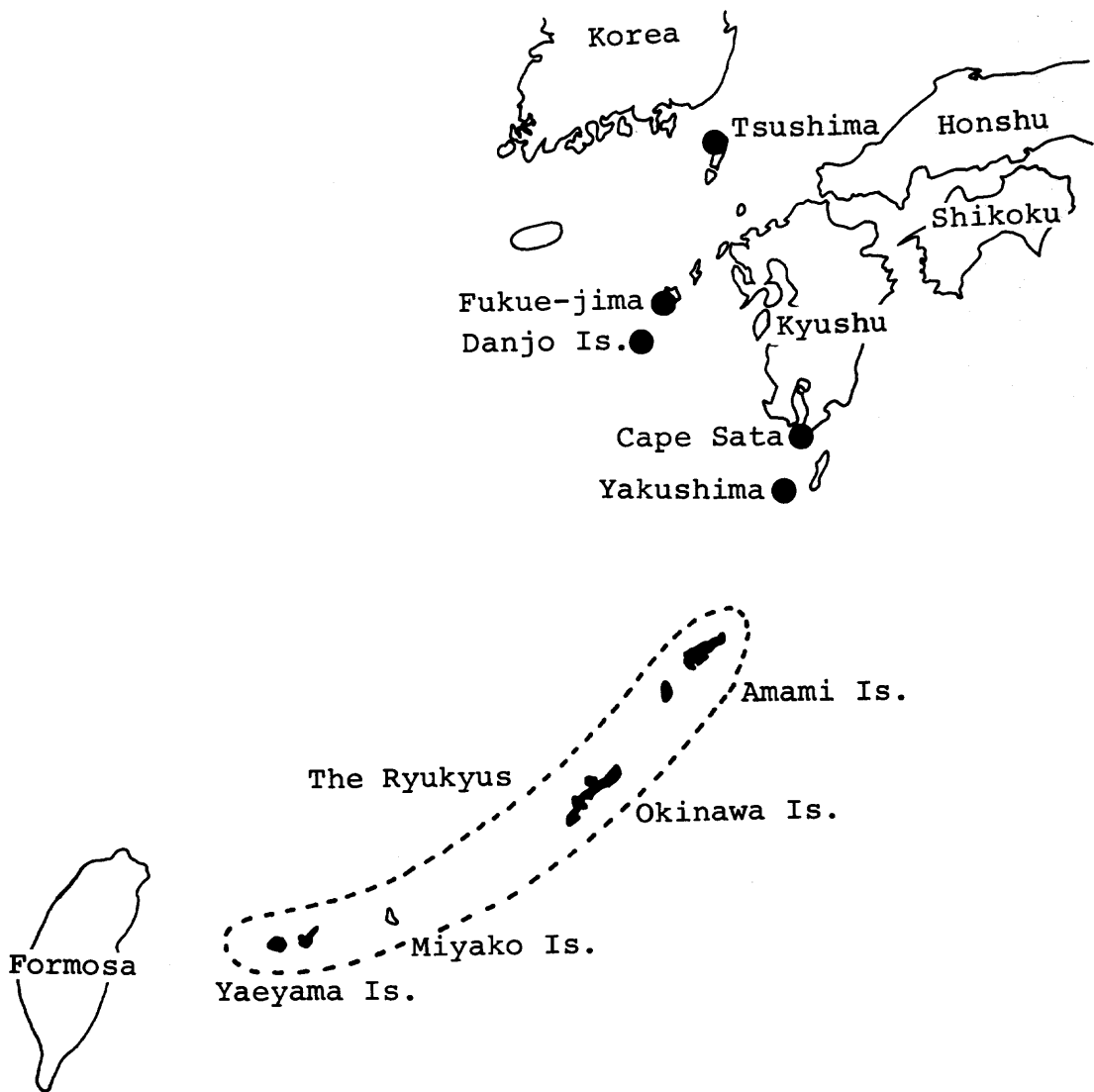


Fig. 1 Known distribution of *Aedes riversi*



Fig. 2 January mean temperature of south Japan (after *Climatic Atlas of Japan* by Japan Meteorological Society). January mean temperature of the blacked out regions is lower than 4°C.